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AEROSOL PREPARATION, GENERATION, AND ASSESSMENT PROJECT HARE

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ABSTRACT

Project HARE was the sixth in a series of experiments in which a radioactive contaminant was released under controlled conditions to simulate the passage of a nuclear event-related radioactive cloud. The history of the radionuclide from the nuclear event to a constituent of man's diet is studied as a function of the interrelated physical, chemical and biological variables. This paper reports on the measurement of some of the physical and chemical parameters involved in the preparation, generation and assessment of the aerosol.

A dry aerosol consisting of submicrometer diatomaceous earth particles tagged with 54.1 mCi of ^{131}I was released over two types of growing forage (alfalfa and Sudan) at the U. S. Public Health Service Experimental Farm at the Nevada Test Site. The study area was instrumented with fallout planchets, glass slides, air samplers, cascade impactors, and meteorological equipment. The aerosol was air-carried over the study area and deposited with an average activity concentration of 1.25 $\mu Ci/m^2$ on the Sudan and 1.43 $\mu Ci/m^2$ on the alfalfa. The count median diameter of the aerosol was 0.6 μm which varied only slightly from one location to another. Average integrated air concentration and average deposition velocity were 87.5 $\mu Ci\text{-}sec/m^3$ and 1.59 cm/sec, respectively.

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I. INTRODUCTION

Five controlled releases of ^{131}I have been conducted at the U. S. Public Health Service (USPHS) Experimental Farm, Area 15, Nevada Test Site. These have included three releases of dry aerosols, one of a hydrosol, and one of ^{131}I gas over various types of forage which were then fed to groups of lactating dairy cows. One of the principal parameters of interest has been the ratio of the peak activity in milk to the peak activity on the forage.

Comparison of the milk to forage ratios for the first two experiments shows that the ratio for Project Alfalfa was approximately four times the ratio for Project Hayseed.[1-2] The two parameters which most probably account for the difference are:

1. Difference in count median diameter (2 μm vs 23 μm) of the aerosols; and
2. Difference in forage species (alfalfa vs Sudan).

The primary objective of Project HARE was to determine whether aerosol particle size, or forage species, if either, contributed to these differing results. Additional objectives included developing procedures for aerosol preparation and generation; determining the deposition, particle size, and aerial concentration of the aerosol; and correlating meteorological data with radiological measurements. The experimental results, as reported in reference 3, indicate that the type of contaminated forage ingested exerts a significant effect upon the resultant ^{131}I activity secreted in milk.

The USPHS Farm lies on a slope with the gravity wind from the north-northwest. Meteorological records were examined to determine the probability of favorable conditions for release. Prior experience at the farm during earlier releases showed that satisfactory conditions (winds 345° ± 30° and speed less than 4 meters per second for a two-hour period) can be expected during periods of light gradient winds and moderate radiative cooling.

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Records for the last three weeks of September for the years 1965 and 1967 were examined. Satisfactory conditions had occurred about 40% of the hours between 2300 PDT and 0700 PDT. A ready time of 0000 PDT with release no later than 0500 PDT was set.

Dry ^{131}I labeled diatomaceous earth (DE) was generated and air-carried over the study area at 0100 hours on September 18, 1968. The study area of Sudan and alfalfa was instrumented with fallout planchets for deposition calculations, glass slides for size measurement, and various types of air samplers for aer .l concentration measurement. Meteorological equipment was also placed at various locations around the study area. It was expected that the desired peak contamination level on the forage of 10^5 pCi/kg could be accomplished with approximately 50 mCi ^{131}I.

II. PROCEDURE

The preparation of the aerosol was accomplished at the Southwestern Radiological Health Laboratory in Las Vegas, Nevada. In the previous exercises the air-dried aerosol, after ^{131}I labeling, was sieved again to assure particle separation. For this exercise the aerosol material (DE), after mixing in the generator flask with the ^{131}I labeling solution, was dried under vacuum and kept sealed in the generator flask until generation time. To assure that 50 mCi of activity would be released, 100 mCi ^{131}I activity was supplied to allow for preparation time and any delays in execution of the experiment. The ^{131}I ($Na^{131}I$ in NaOH solution) received from the supplier was diluted to 17 ml and divided into 32 x 0.5 ml aliquots, one aliquot for each of 32 generator flasks. The extra 1 ml was used for calibration purposes. Each aliquot was put into a 2 oz polyethylene bottle containing 1 ml 1M $Na_2S_2O_3$, 5 ml 2M Na_2CO_3 and 25 ml distilled water.

The generators (2000 ml, two neck, round bottom flasks) were prepared in two groups of 16. Stoppers were wired to the flasks and included as part of the flask tare weight. Each flask was placed in double plastic bags taped to close the bags about the flask necks to ensure containment should the flask break. The plastic bags remained around the flask throughout the

preparation, transportation, and generation of the aerosol. A screen was placed in the outlet ports of the flasks to assist in the break-up of any agglomerates. Isopropanol (450 ml) and 7 g of glass beads (3mm diameter) were added to each flask. The ^{131}I spike aliquots were added to the flasks under a hood behind a lead shield. Each flask was stoppered and its contents mixed thoroughly. A 150 g portion of presized DE was added to each flask, the flasks stoppered, then swirled to mix the contents. The DE was presized by sieving using a Tyler sieve shaker with 400 mesh (37 μm pore size) screen as the final stage. All 16 flasks, after being prepared in this manner, were connected to the vacuum manifold. The first group of 16 flasks was dried for 40 hours, being warmed by hot tap water for the last 18 hours. The second group was vacuum dried for 45 hours, being warmed by hot tap water for the last 17 hours. The flasks were brought back to atmospheric pressure, stoppered, individually weighed, and transported to the test site in lead-lined boxes. After generation of the aerosol, the flasks were again individually weighed to determine the weight loss, i.e., the amount generated.

Before the actual release a sampling grid was set up at the USPHS Farm, and is shown in Figure 1. The Sudan portion of the study area, located on the east end of the field, measured 65 m by 16 m. The alfalfa portion of the study area, located on the west side, measured 55 m by 16 m. A 10 m space separated the two areas. The samples and samplers were numbered from left to right across the complete grid and from front to back.

Stainless steel 4½-inch planchets coated with alkyd resin were spread over the sampling grid on wooden stakes approximately ½ m off the ground. The data from planchets were used to determine the activity level isopleths and as input to deposition velocity calculations. Additional planchets were placed in the center rear of the study area for special forage studies. Racks containing planchets having both horizontal and vertical orientations at ground, 1 m and 2 m levels were located at three different positions in the study area to yield a measure of the vertical profile of the cloud. Glass slides placed evenly throughout the study area were used to determine the size distribution of the aerosol. Fallout trays were evenly spaced to aid in obtaining a size to activity ratio

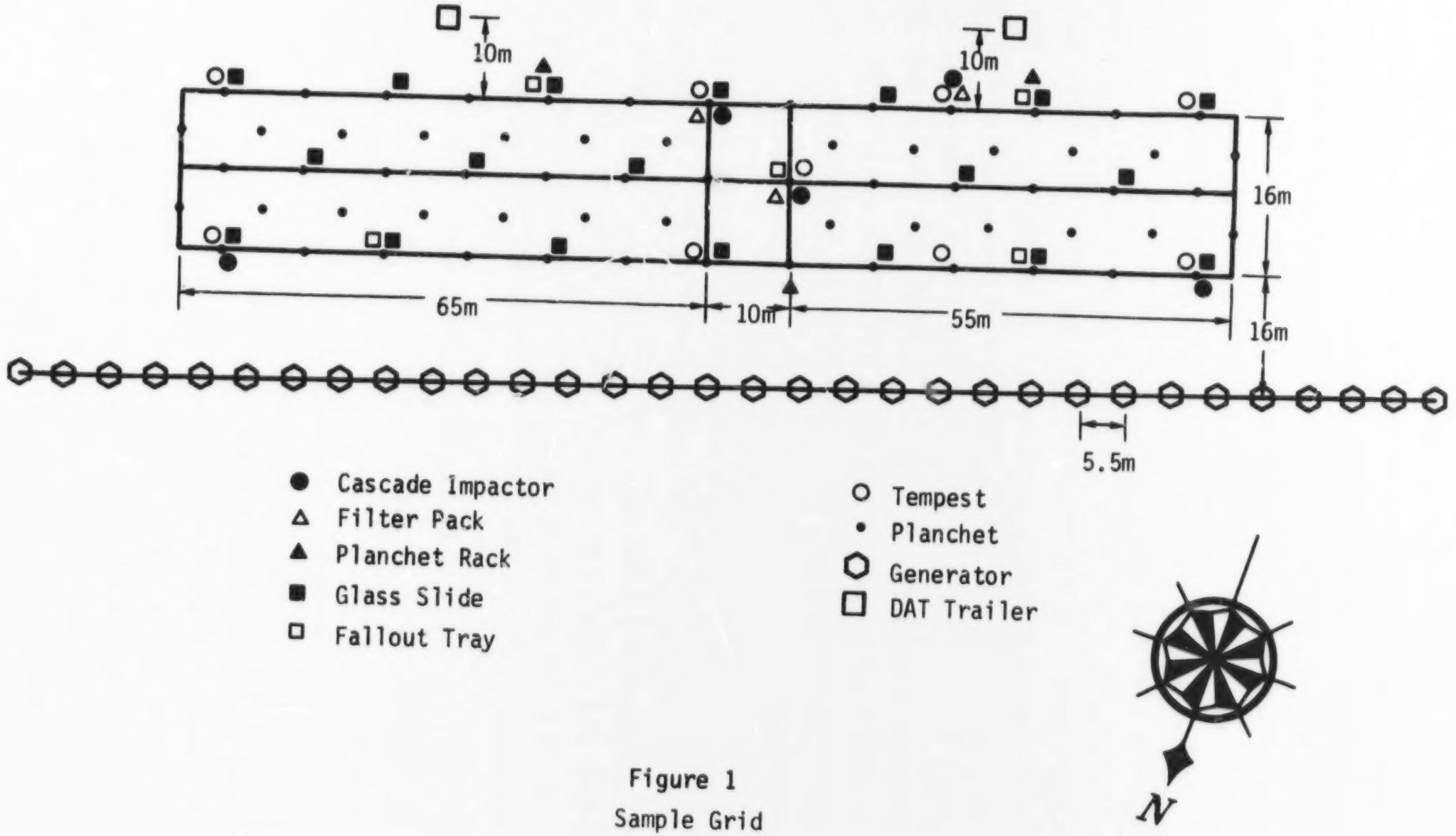


Figure 1
Sample Grid

Gelman Tempest air samplers were placed at nine locations throughout the study area to measure airborne activity concentrations. Each Tempest filter train consisted of a Whatman 541 prefilter, MSA charcoal cartridge and Microsorban postfilter.

Three additional air samplers which made use of a special sampling train consisting of a Microsorban prefilter, AC-1 charcoal filter, 727 charcoal bed, and Microsorban postfilter were also used to aid in quantitating aerial activity concentrations.

Unico cascade impactors were placed at five locations in the study area to aid in determining the distribution of the activity with particle size, and to correlate this with activity levels.

A line of 32 generators spaced at intervals of 5.5 m was fixed parallel to and 16 m upwind of the leading edge of the test field. The generator line extended four generators beyond each end of the field to allow for wind changes up to 30° from the normal. One cylinder of dry air was used as the generation gas for each group of two generators. At 0100 hours PDT on September 18, 1968, the aerosol was generated with a dry air flow rate of 85 liters per minute to each flask. During the period of generation the flasks were agitated by hand to insure complete unloading. The generation period lasted for an average of 11 minutes.

Two analog wind systems, with telemetered data to the farm building, were set at a height of 1 m on each end of the experimental plot--one over alfalfa, the other over Sudan grass. Two Data Acquisition and Telemetry (DAT) trailers each having aspirated temperature sensors and wind direction and velocity sensors at 9.4 m and 0.4 m elevations were located 10 m downwind of the test plot, one centered on the Sudan plot, the other centered on the alfalfa plot. The trailer instrumentation gave printouts at two-minute intervals of air temperature and the temperature differences between elevations. Hygrothermographs in standard instrument shelters at a height of 0.25 m were located, one 200 m northeast of the plot, the other in the alfalfa at the edge of the experimental plot. Analog wind information was also available from the farm meteorological tower located 110 m north of the study area with instrumentation at 1 m, 10 m, and 30 m elevations.

At 0100 PDT, September 18, 1968, the skies were clear, with the wind at 1 m elevation from the northwest at 2 mph (0.9 m/sec). A pronounced surface inversion had been established. The temperature difference between the 9.4 m and 0.4 m levels ranged from 16 to 20 F° (Table I). This was a larger difference than in any earlier tests. The wind flow was observed to occasionally meander with the direction stabilizing from the northwest. The wind was steady in direction during the release period, and no temporary breakdown of the extremely stable temperature structure occurred. Table II gives wind information during and shortly after the release at three elevations on the meteorological tower and on either end of the test plot. No precipitation was recorded during the period of the test.[4] Some mean values (with instrument uncertainty indicated) measured during the release period are:

wind speed - 1 m Sudan -	1.3 ± 0.2 m/sec
wind speed - 1 m alfalfa -	1.2 ± 0.2 m/sec
mean direction of wind -	326° ± 5°
temperature - 0.25 m alfalfa -	51 ± 1°F
humidity - 0.25 m alfalfa -	51 ± 5%
temperature difference (9.4 m - 0.4 m) -	18.7 ± 0.5 F°

TABLE I

AIR TEMPERATURE AND HUMIDITY DATA

	Alfalfa Test Plot		Alfalfa DAT System		Sudan DAT System	
Time (PDT)	Temp. (°F)	Rel. Hum. (%)	0.4m Temp. (°F)	9.4m-0.4m ΔTemp. (F°)	0.4m Temp. (°F)	9.4m-0.4m ΔTemp. (F°)
0100	51	50	46	18.1	49	16.7
0101	51	50				
0102	51	50	46	16.5	46	17.6
0103	51	50				
0104	51	50	47	16.5	47	17.0
0105	51	50				
0106	51	50	46	17.8	48	17.0
0107	51	50				
0108	51	50	46	19.2	47	18.4
0109	51	50				
0110	51	51	45	19.2	47	18.2
0111	51	51				
0112	51	51	47	18.9	47	18.5
0113	51	51				
0114	50	52	47	19.6	47	18.9
0115	50	52				
0116	50	53	46	20.3	47	18.9
0117	50	53				
0118	50	53	46	20.6	48	19.1
0130	50	54				

TABLE II

WIND DATA

Time (PDT)	Sudan 1m		Alfalfa 1m		Tower 1m		Tower 10m		Tower 30m	
	Wind Dir. (°True)	Wind Vel. (mph)	Wind Dir. (°True)	Wind Vel. (mph)	Wind Dir. (°True)	Wind Vel. (mph)	Wind Dir. (°True)	Wind Vel. (mph)	Wind Dir. (°True)	Wind Vel. (mph)
0100	340	02	340	02	340	03	320	05	020	04
0101	340	03	325	02	340	04	335	05	030	05
0102	350	03	315	02	345	04	320	05	025	05
0103	360	02	330	02	310	03	335	05	025	05
0104	335	02	335	03	310	03	345	04	030	04
0105	315	03	330	02	310	04	320	04	030	04
0106	320	03	330	03	315	04	320	05	030	04
0107	320	03	325	03	330	03	320	05	010	04
0108	325	03	330	03	315	04	330	05	030	04
0109	325	03	320	03	310	03	325	04	030	03
0110	320	03	320	03	310	03	320	03	030	03
0111	320	03	320	03	310	03	310	03	035	03
0112	320	03	315	03	310	03	320	03	030	04
0113	315	03	320	03	310	04	315	03	025	04
0114	315	03	325	03	315	04	315	03	025	04
0115	320	03	330	03	315	04	315	03	025	04
0116	320	03	330	03	315	04	315	03	020	04
0117	325	04	335	03	320	04	315	04	015	04
0118	325	04	335	03	325	04	315	04	020	04
0130	325	03	330	03	325	04	320	03	030	04

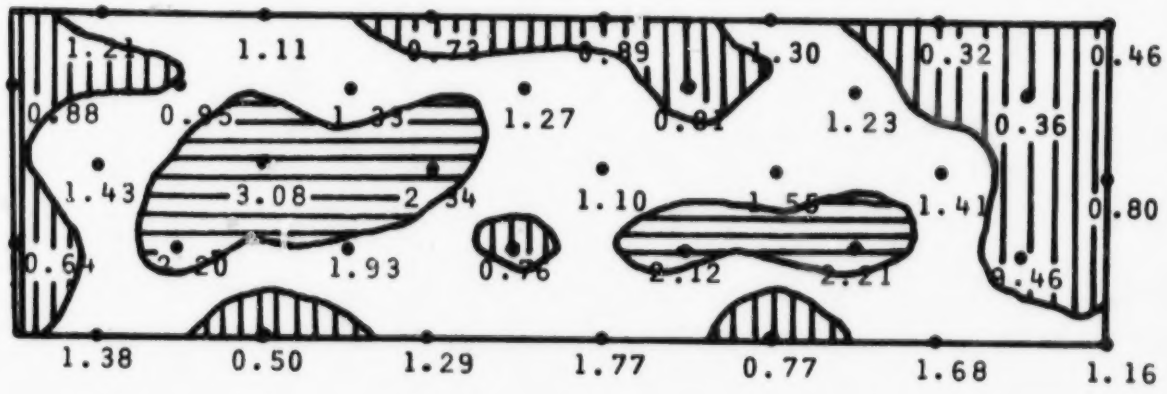
III. RESULTS

During the aerosol preparation procedure a cold trap was used between the flasks and vacuum pump. Approximately 68 μCi (0.1%) of ^{131}I activity was collected in the cold trap during the drying procedure.[5] The loss of activity to the vacuum pump oil was determined to be less than 0.02% of the total activity. A Tempest air sampler was operating near the vacuum pump exhaust. A total of four prefilters and charcoal cartridges were used during the drying procedure. No activity was found on the prefilters, but there was activity found on the charcoal cartridges. The maximum air concentration was found to be 2.69×10^{-4} pCi/cm^3, which is well below the maximum permissible concentration $(MPC)_a$ of 9×10^{-3} pCi/cm^3 based on a 40-hour week.[6] The same methods of preparation could be used with considerably more activity without exceeding the $(MPC)_a$.

The generator flasks were reweighed following the exercise. Based on the average weight lost, 98% of the activity was generated. This represents a total of 54.1 mCi ^{131}I released during the exercise.

The activity deposited on the field as determined by the planchets along with the activity isopleths are shown in Figure 2. By using the average planchet value of 1.25 μCi/m^2, a total of 1.29 mCi or 2.4% of the total activity released was deposited on the Sudan grass plot. By using the average planchet value of 1.43 μCi/m^2, a total of 1.26 mCi or 2.3% of the total activity released was deposited on the alfalfa study plot. The total activity deposited on the test grid was 2.55 mCi, or 4.7% of the activity generated.

The data obtained from the planchet racks together with the respective "depletion vectors" is shown graphically in Figure 3. The "depletion vector" is defined as the resultant deposition vector, using the normal to the vertical and horizontal orientations of the planchets as vectors and the corresponding activities as magnitudes. These data demonstrate that the cloud was concentrated very close to the ground in a near vertical deposition direction. At the higher elevations the horizontal component becomes relatively stronger and the magnitude of the resultant vector decreases.

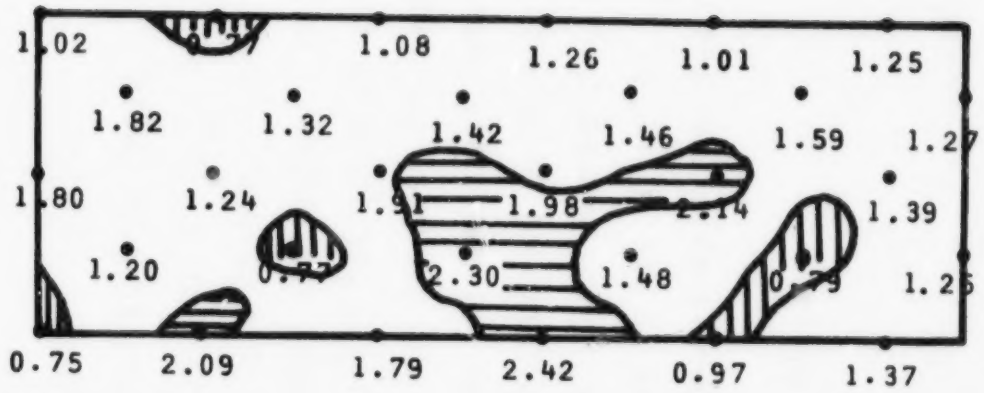


Sudan

Act.>2 μCi/m²

1<Act.<2

Act.<1



Alfalfa

Mean wind direction

N

Figure 2
Activity Deposition Distribution

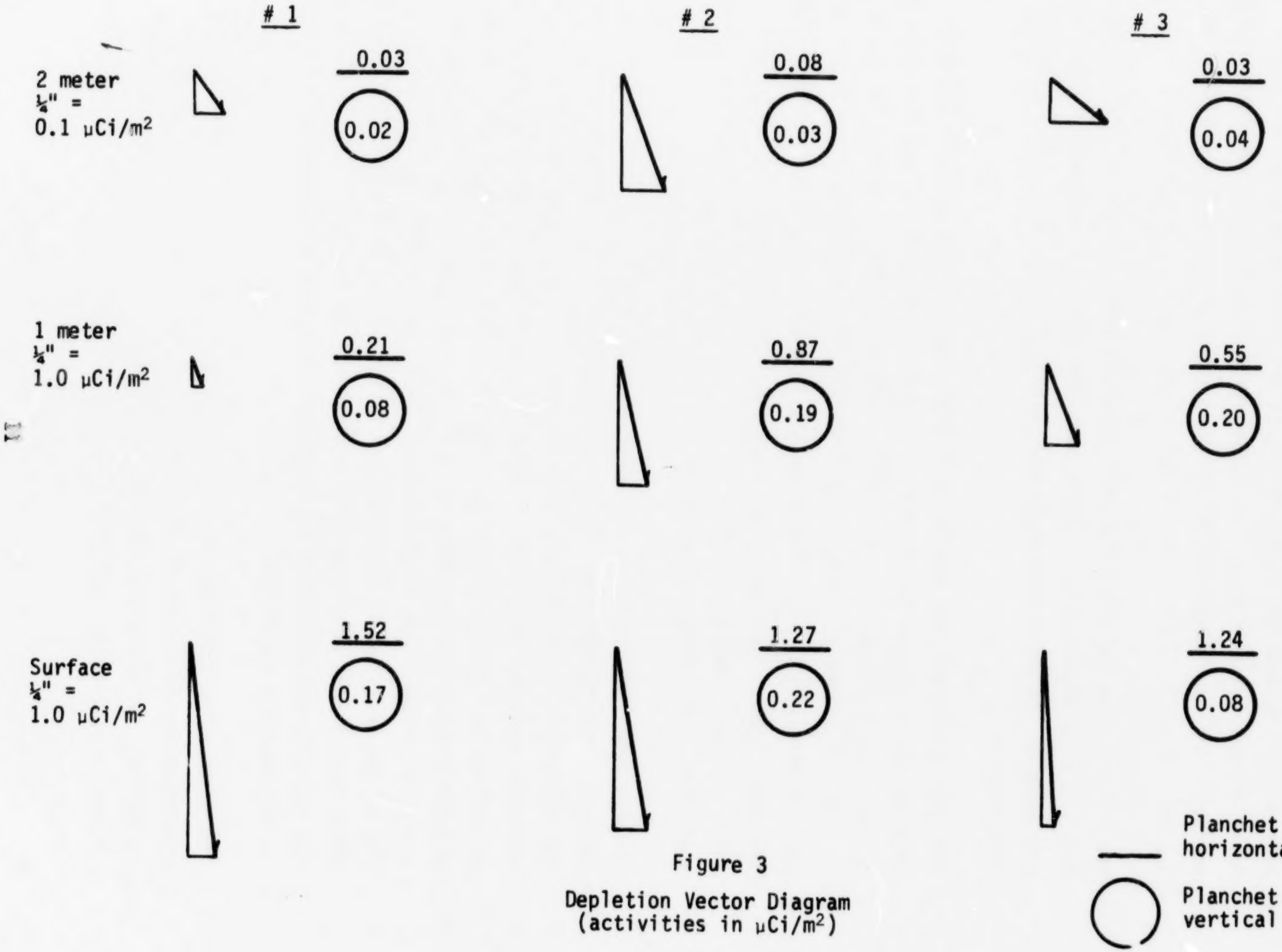


Figure 3

Depletion Vector Diagram
(activities in μCi/m²)

The DE particles on 19 glass slides were examined and sized under an optical microscope. An average of 400 particles per slide were sized using the Feret diameter measurement.[7] The cumulative size distribution data is shown in Table III. The count median diameter (CMD) of the entire distribution is 0.6 μm.

Portions of five fallout trays were observed under an optical microscope to obtain a size distribution. These same portions were autoradiographed and the spots on the autoradiographs were sized to obtain a relative activity distribution.

The data collected from the Unico cascade impactors is shown in Table IV. No data was collected for the No. 4 cascade impactor as it was not operating during cloud passage. The mass median diameter (MMD) indicated in Table IV is that calculated for each stage from the cascade impactor flow chart based on a DE density of 2.3.[8] The stage MMD represents that size whereby 50% of the mass impacted on that stage is associated with particles less than that size. A large fraction (83-87%) of the activity was associated with large particles, i.e., those collected on the first stage.

Table V shows that activity collected on each component of the Gelman Tempest air sampler heads. It also shows the integrated air concentrations, the deposition velocities, and the ratios of the prefilter activity to the charcoal cartridge activity. Integrated air concentration (IAC) is defined as the ratio of the total activity on the filter elements to the flow rate through those elements. Deposition velocity is the ratio of the planchet activity per unit area to the integrated air concentration. An average of 49% of the activity collected on the filter trains remained on the prefilters which have a mean pore size of 3.4 to 5 μm. An average of less than 1% of the activity was collected on the postfilters with a 50% average remaining on the charcoal cartridges.

The Microsorban prefilter on filter pack air sampler Nos. 1 and 3 (Table VI) accounted for 63 and 63.9% respectively of the total activity at their locations. An additional 36.7 and 35.7% was collected on the Gelman AC-1 filter, thus leaving less than 1% on the combination of the charcoal bed

TABLE III

PARTICLE SIZE DISTRIBUTION

Size Range (μm)	Number	Percent	Cumulative Number	Cumulative Percent
<.64	2547	32.6	2547	32.6
.64- .96	2827	36.2	5374	68.8
.96-1.60	898	11.5	6272	80.3
1.60-2.24	314	4.0	6586	84.3
2.24-2.88	116	1.5	6702	85.8
2.88-3.52	81	1.0	6783	86.8
3.52-4.16	57	0.8	6840	87.6
4.16-4.80	69	0.8	6909	88.4
4.80-5.44	53	0.7	6962	89.1
5.44-6.08	43	0.6	7005	89.7
6.08-12.5	236	3.0	7241	92.7
12.5-18.9	164	2.1	7405	94.8
18.9-51.2	226	2.9	7631	97.7
>51.2	196	2.3	7827	100.0

TABLE IV

CASCADE IMPACTOR DATA

Stage	Number 1 Activity ($pCi\ ^{131}I$)	Number 1 %	Number 1 MMD (μm)	Number 2 Activity ($pCi\ ^{131}I$)	Number 2 %	Number 2 MMD (μm)	Number 3 Activity ($pCi\ ^{131}I$)	Number 3 %	Number 3 MMD (μm)	Number 5 Activity ($pCi\ ^{131}I$)	Number 5 %	Number 5 MMD (μm)
1	3.00×10^4	87.7	>5	2.06×10^4	83.5	>4.8	1.49×10^4	87.6	>5	1.31×10^4	83.7	>5.8
2	7.06×10^2	2.0	5.0	1.92×10^3	7.7	4.8	1.06×10^3	6.2	5.0	9.60×10^2	6.1	5.8
3	6.34×10^2	1.8	2.5	1.14×10^3	4.6	2.7	4.73×10^2	2.7	2.5	3.76×10^2	2.4	3.2
4	2.21×10^3	6.4	1.3	5.91×10^2	2.3	1.2	3.23×10^2	1.8	1.3	6.27×10^2	4.0	1.4
Postfilter	6.22×10^2	1.8		4.16×10^2	1.6		2.46×10^2	1.4		5.81×10^2	3.7	
TOTAL		99.7			99.7			99.7			99.9	

NOTE: Number 4 cascade impactor was inoperative.

MMD - Mass Median Diameter

TABLE V

AIR SAMPLER DATA

Sampler Number	Prefilter[1] (10^4 pCi)	Charcoal[2] (10^4 pCi)	Postfilter[3] (10^4 pCi)	Total (10^4 pCi)	Prefilter Charcoal	Integrated Air Conc. (μCi-sec/m^3)	Deposition[4] Velocity (cm/sec)
1	34.9	36.3	0.0925	71.3	0.961	161	.859
2	16.6	20.8	0.291	37.7	0.798	82.0	1.42
3	17.8	24.2	0.358	42.4	0.735	86.9	2.06
4	24.9	20.2	0.230	45.3	1.23	98.5	1.39
5	20.1	17.1	0.281	37.5	1.18	76.8	2.34
6	23.7	21.9	0.220	45.8	1.08	93.8	1.29
7	2.92	7.78	0.0949	10.8	0.375	2[illegible] 1	2.08
8	29.1	11.7	0.0724	40.9	2.49	92.[illegible]	1.17
9	16.9	19.2	0.329	36.4	0.880	74.6	1.68
AVERAGE	20.8	19.9	0.219	40.9	1.08	87.5	1.59

(1) Whatman 541

(2) MSA Cartridge #46727

(3) Delbag Microsorban

(4) Calculated relative to planchets

TABLE VI

FILTER PACK DATA

Sample	Activity (pCi)	Percent	Integrated Air Conc. ($\frac{\mu Ci\text{-}sec}{m^3}$)	Deposition Velocity ($\frac{cm}{sec}$)
Prefilter(1)	2.74×10^5	63.0	77.8	2.31
Charcoal Filter(2)	1.60×10^5	36.7		
Charcoal Bed(3)	1.24×10^3	0.3		
Postfilter(1)	2.72×10^2	0.1		
TOTAL	4.36×10^5	100.0		
Prefilter(1)	5.21×10^4	37.8	23.8	1.94
Charcoal Filter(2)	8.39×10^4	60.8		
Charcoal Bed(3)	1.66×10^3	1.2		
Postfilter(1)	4.42×10^1	0.1		
TOTAL	1.38×10^5	99.9		
Prefilter(1)	1.88×10^5	63.9	52.5	2.06
Charcoal Filter(2)	1.05×10^5	35.7		
Charcoal Filter(2)	4.36×10^2	0.1		
Charcoal Bed(3)	3.36×10^2	0.1		
Postfilter(1)	4.47×10^2	0.2		
TOTAL	2.94×10^5	100.0		

(1) Delbag Microsorban

(2) Gelman AC-1

(3) 727 Charcoal Bed

and the Microsorban postfilter. An extra Gelman AC-1 filter was placed in the third sampler in error; however, less than 0.1% of the total activity was collected on that sample. No change in flow rate resulted from this extra filter since flow rate was set to a predetermined value. Filter pack No. 2 yielded a prefilter to charcoal filter ratio that was about the inverse of the other two samplers. This same low ratio can also be noted from Tempest air sampler No. 7 on Table V. These latter two air samplers were located at the right rear corner of the Sudan plot which received the lowest level of contamination of the total test grid.

A comparison of two methods of calculating deposition velocity is shown in Table VII. Lines 2 and 4 show the deposition velocities calculated using the planchet deposition. In lines 1 and 3 the deposition velocity is calculated using the deposition on the forage itself. This activity is calculated from the activity per unit mass on the forage and from the average density of the forage per unit area of ground surface, given in columns 1 and 2, respectively. The integrated air concentration is calculated using Tempest sampler No. 7 for the Sudan, and using the average of the values from Tempest samplers 5 and 8 for the alfalfa.

IV. DISCUSSION

The distribution of the aerosol was reasonably uniform over the entire study area. The area of lowest deposition was the southwest corner of the Sudan study plot with a deposition of about 1/3 of the average deposition on the Sudan. By comparing the averages of the five lengthwise rows of planchets (Figure 2), it can be seen that the center row received the highest deposition with the level falling off both front and rear.

The planchet racks (Figure 3) demonstrated that most of the activity remained very close to the ground, i.e., less than 1 m.

It appears that a large amount of the activity is associated with larger particles, since such a large portion of the activity was collected on the first stage of the cascade impactors. The size measurements indicate that more than half of the particles are quite small (<1 μm). Unfortunately,

TABLE VII

DEPOSITION VELOCITIES

Deposition Surface	Forage Activity (pCi/g)	Forage Areal Density (g/m^2)	Areal Activity (pCi/m^2)	Integrated Air Conc. ($pCi\text{-}sec/m^3$)	Deposition Velocity (cm/sec)
Alfalfa	5.23×10^3	3.90×10^2	2.04×10^6	8.44×10^7	2.42
Planchet (Alfalfa Plot)			1.44×10^6	8.44×10^7	1.75
Sudan	1.98×10^3	2.97×10^2	5.88×10^5	2.22×10^7	2.68
Planchet (Sudan Plot)			4.6×10^5	2.22×10^7	2.08

accurate measurements of size to activity ratios using the fallout trays were not possible. Accurate measurements of this value would require precise positioning of an autoradiograph in back of the fallout tray or glass slide so that the particle would appear directly over the spot it created on the X-ray film. In this way the particle could be sized, its autoradiograph sized, and a direct comparison made of its size to its activity. In using the fallout trays, great difficulty was encountered in relocating the autoradiograph in its proper position for the measurements. In nearly all cases the active particle could not be relocated over its autoradiograph spot.

A careful examination of the filter pack activity collection data (Table VI), the cascade impactor data (Table IV), and the particle size distribution (Table III), together with a consideration of the reported efficiency of the Microsorban filter, suggests that something must have happened to some of the radioiodine that had been stopped by the Microsorban prefilter to cause it to be carried off the prefilter and be subsequently collected by the AC-1 filter (charcoal impregnated paper) in the filter pack system. The Microsorban filter has a reported efficiency of 99.9% for 0.3 μm size particles and has a high efficiency for much smaller particles. Table III shows that 67.4% of the aerosol particles were 0.6 μm or larger. It would be expected that only a very small fraction of the aerosol would be particles smaller than 0.3 μm. Then greater than 75% of aerosol particulate should have been collected by the prefilters.

Microsorban filters which were the last collecting stage of the cascade impactor system collected only a 2.15% average of the activity of the four cascade impactor systems. The first stages of the cascade impactor systems collected an average of 85.6% of the system activity. Therefore, most of the ^{131}I activity must have been associated with the larger particles.

The question then, is how could so much of the ^{131}I activity have penetrated the Microsorban prefilters of the filter pack systems (36.7%, 60.8%, 35.7%) then to be collected by the AC-1 filters? The ^{131}I activity was put on the DE aerosol in the form of stabilized $Na^{131}I$.

Examination of the Tempest sampler data (Table V) suggests that the same thing may have happened there even though the Whatman 541 filter is known to be less efficient than the Microsorban filter. The Whatmah 541 filter has a pore size of 3.4-5 μm. The average percent of the activity on Whatman filters for the nine Tempest samplers was 48.9% and the average activity on the charcoal cartridge was 50.5%. Again it would seem unlikely that so much of the activity would penetrate the Whatman filter when such a large fraction of the activity in the cascade impactor systems was collected in the first stage (85.6%). The Whatman filter ought to have a very high efficiency for the particles of the size collected by the first stage of the cascade impactors.

Two explanations are offered as possible mechanisms by which some of the prefilter ^{131}I activity was carried off the prefilters then was subsequently collected by the AC-1 filter of the filter pack system and by the charcoal cartridge of the Tempest system. Erosion of the DE particles on the prefilters to particles small enough to penetrate the prefilters then to be collected efficiently by the AC-1 filter and the charcoal cartridge is offered as one plausible mechanism. The oxidation of the I^- (solid as NaI) form of ^{131}I activity to the I_2 form by a reaction such as $4I^- + O_2 + 2H_2O \rightarrow 4OH^- + 2I_2$ caused by the large volume of air being drawn through the prefilter is offered as another probable mechanism. The I_2 formed by such a reaction would be collected very efficiently by the Gelman AC-1 charcoal filter. The latter mechanism is believed to be the more probable.

Extremes of deposition were about an order of magnitude apart and extremes of integrated air concentration a factor of seven different. Deposition velocities computed from the air filters and adjacent planchet activity are shown in Table V. Values range from 0.86 cm/sec to 2.34 cm/sec with a mean of 1.6 cm/sec. Grouping the planchet deposition velocities into those measured over alfalfa and those over Sudan grass gives means of 1.73 cm/sec for alfalfa plot planchets and 1.4 cm/sec for Sudan plot planchets. A two-tailed Students "t" test indicates no statistically significant difference between the two groups at the 0.01 or 0.05 levels.[9]

The ratio of activity per unit mass (dry weight) of vegetation measured on the alfalfa to that measured on the Sudan is 2.65 (Table VII). Mean values were 5.23×10^3 pCi/g for alfalfa and 1.98×10^3 pCi/g for the Sudan. Air sampler measurements of integrated air concentrations for the samplers closest to the location of the cutting samples give deposition velocities of 2.42 cm/sec on the alfalfa and 2.68 cm/sec on the Sudan. Planchet deposition velocities at these positions were 1.75 cm/sec and 2.08 cm/sec, respectively.

Quantitative analysis of these differences requires determination of leaf area to ground surface area ratios as a function of the height of the plant above the ground and the distribution of radioactivity within the plant canopy.

V. CONCLUSIONS

The method of preparing the aerosol by the vacuum drying procedure is a satisfactory one and higher levels of activity could be prepared in the same manner without exceeding the $(MPC)_a$ in air for ^{131}I in the preparation room.

An analysis of the experimental results indicates the need for:

1. An accurate method of determining a size to activity ratio. Glass slides could be used much more effectively than fallout trays as they allow for more accurate repositioning of the X-ray film with minimum disturbance to the particles themselves.
2. A thorough knowledge of the efficiencies of the various components of air sampling trains and other aerosol collection devices as a function of environmental parameters, e.g., temperature, relative humidity, wind speed, etc.
3. A further knowledge of meteorological factors and how they affect deposition mechanisms.
4. A further knowledge of the behavior of particulate associated $Na^{131}I$ in air streams.

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